IMPACTS OF USING DYNAMIC FEATURES ON CHANGEABLE MESSAGE SIGNS

Technical Memorandum 7510-2

Task 3 Experimental Designs for Driver Simulator Studies

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INTRODUCTION

Background

The rationale for and the objectives the current study are presented in Technical Memorandum 7501-1, Task 3 Experimental Designs for Human Factors Laboratory Studies dated February 2004. The Technical Memorandum also contains the experimental design for the human factors laboratory studies.

General Study Approach

Upon the recommendation of the FHWA Contract Officer's Technical Manager (COTM), the Texas Transportation Institute (TTI) will conduct driver simulator studies using TTI's driver simulator located in College Station, Texas.

The driving simulator is comprised of four components: vehicle, computers, projectors, and screens. The vehicle, a complete and full-size 1995 Saturn SL automobile, is outfitted with computers, potentiometers, and torque motors connected to the accelerator, brakes, and steering. The Saturn also features full stereo audio, full instrumentation, and fully interactive vehicle components, all of which provide a feel of driving. The Saturn is connected to a computer component that consists of one data collection computer and three image generation computers. Computer-generated driving scenes are sent to three high-resolution projectors and projected to three high-reflectance screens.

TTI has the capability for projecting several different highway scenes and scenarios. The combination that presents the subject with the highest driving workload that is possible within the capability of TTI's simulator while minimizing the possibility of subject nausea will be used for the current project. It should be noted that the driver work load presented by the simulator is less than actual real-world complex freeway driving and signing situations that result in very high work loads. The proposed "driving" scene will be a six-lane urban freeway with primarily tangent sections with slight horizontal curvature. In addition to "driving" the vehicle on the freeway, additional work load will be introduced via a car-following approach.

One of the primary measures of effectiveness in the current study is driver reading times of the CMS messages. To ensure that reading times are measured accurately and consistently, the stimulus presentation must be controlled so that the researchers know the exact time at which each subject can begin reading the message. Therefore, the stimulus in the form of CMS messages will be projected on a large rectangle that replaces a portion of the simulator roadway scene rather than intermixed with the simulator software scene. The projection will be accomplished using an add-on LCD projector interfaced with a laptop computer. The test administrator will push a button at predetermined locations on the freeway whenever it is desirable to display a sign. A second push button will be attached near the steering wheel of the car and will be depressed by the subject when he/she reads and understands the message. Depressing the button will remove the message from the scene and will automatically be recorded on the laptop computer.

Driver Simulator Instrument

Comparable to the laboratory studies, the three CMS dynamic display research issues evaluated in the driver simulator were developed as independent studies and are shown in the subsequent major sections in this Technical Memorandum. The primary messages (see Appendix A) for each or the three issues, however, will be presented within an overall session for each subject. Furthermore, the subject pool will be divided into two groups and the order of the primary messages displayed will be counterbalanced to avoid the occurrence of primacy bias. Because it will be necessary for a subject to view each message twice, a large set of other messages and static guide signs (not shown in this document) that are not related to the specific objectives of the current study will be intermixed with the primary messages and questions will be asked of the subjects as a means of separating the primary messages in time and to avoid subjects from concentrating only on the dynamic messages.

Each subject will be placed in a "driving" workload situation. The subject will be asked to follow a selected vehicle while traveling on the freeway. The high work load will be simulated by having the speed of the lead vehicle vary significantly whenever a CMS message is displayed.

Pilot Study

After the preliminary drive simulator instrument is developed, a pilot study will be conducted with two subjects from the College Station area. The purpose of the pilot study is to assess the administration procedures, determine the length of time needed for each subject to complete the study, and to identify any question deficiencies. The preliminary driver simulator instrument will be modified based on the results of the pilot study.

Participant Recruitment

Fifty-two individuals from the College Station area will participate in the driver simulator study. Because the dynamic features of CMSs that will be evaluated will be primarily used on freeways and highways, all subjects will be required to have a current state driver's license, drive at least 8000 miles per year, and travel on a freeway or highway at least 12 times per year.

The 52 subjects who participate in the studies in College Station will also participate in the College Station laboratory studies that are described in Technical Memorandum 7510-1. Half of the subjects will participate in the driver simulator studies before the laboratory studies and half will participate in the laboratory studies before they participate in the driver simulator studies. One of the reasons why the same subjects will be used in both the laboratory and driver simulator studies is to determine whether the results of the two study techniques are comparable. If so, then better informed decisions can be made regarding the relative usefulness of laboratory studies using laptop computers and driver simulator studies for future studies.

Demographics

The demographic sample of drivers will be based on age, gender, and education in Texas.

Driver Simulator Session Protocol

Each subject will undergo a short session to get familiar with procedures and equipment. The subjects will then "drive" on a predetermined freeway route during a series of sessions. Prior to each session the study administrator will read instructions and will make sure that the subject understands what he/she is to do. As the subject "drives" on the simulated freeway, stimulus material in the form of CMS messages will then be displayed on a rectangular section of the driving scene at specific times during the trip. The time that each CMS message is displayed will be controlled to ensure that the specific scenes and conditions are the same for each CMS display. This control is necessary to minimize variability of the results. Following the display of a CMS message, the study administrator will ask the subject specific questions about the message which will require open-ended responses. Sufficient time will be allowed between sign displays to ensure that the subject has sufficient time to respond to the question before any other sign is displayed. Several other signs such as guide signs will be periodically displayed. The study administrator will ask questions about these signs as well. This procedure will help ensure that the subject does not concentrate solely on the CMS messages.

The study administrator will also record notes concerning the driver's handling of the vehicle such as reducing speed when a message is displayed, braking, edge line encroachments, and headways. These characteristics will also be recorded automatically by the driver simulator system.

EXPERIMENTAL DESIGN FOR TASK 3 DRIVER SIMULATOR STUDIES

STUDY 1: EVALUATE FLASHING AN ENTIRE ONE-PHASE MESSAGE VS NON-FLASHING ONE-PHASE MESSAGE

Objectives

The objectives of this study are to conduct human factors studies under driver work load conditions to:

1. Compare comprehension of a one-phase flashing message with a non-flashing message;
2. Compare the perception of the importance of the information on a non-flashing one-phase message with a flashing message.
3. Determine driver preferences for each of the two message styles; and
4. Determine driver reading times for each of the two message styles.

Background

It is not clear how comprehension and the amount of time it takes to read a CMS message will be affected by a flashing one-phase message versus a non-flashing message when a driver is under work loads. Also, it is not clear if drivers perceive a degree of importance or urgency of information on a flashing message versus a non-flashing message.

Method

The characteristics of the study design are shown in Table 1. The study will be counterbalanced by dividing the subjects into two groups. Group A consisting of 50 percent of the subjects will view Part 1 and Part 2 of the study that involve comprehension of messages. This will be followed with Part 3 and Part 4 to obtain driver preferences. Group B, the other 50 percent, will view Part 5 and Part 6 for message comprehension measurements followed by Part 7 and Part 8 for driver preferences information.

In Part 1 and Part 2 (Group A) and Part 5 and Part 6 (Group B) of the study, two one-phase messages will be displayed to the subject in the driver simulator one at a time. The messages will be shown at different points within a larger study. The text will be the same with the exception that one message will flash and the other will not flash. Each message will be displayed for a total of 8 seconds. The flashing message will be displayed alternately 2 seconds on and a half-second off, which is comparable to flash rates used by some state DOTs. This process will continue automatically for a total of 8 seconds. The non-flashing message will be displayed continuously for a total of 8 seconds. The time of eight seconds was chosen because it is equivalent to the available reading time of typical CMSs while drivers are traveling at 90 km/h (55 mi/h).

The subjects will be asked questions to evaluate their comprehension of the message content for each message style. In addition, they will give their preferences for the message styles.

Table 1. Characteristics of Study Design

Study Part	Group	Message Type	Message Text	Output
Group A: 50% of Subjects				
Part 1	Group A	Flash message	1	Comprehension
Part 2	Group A	Static message	2	Comprehension
Part 3	50 % of Group A	Flash message seen last	1	Preference
Part 4	50% of Group A	Static message seen last	2	Preference
Group B: 50% of Subjects				
Part 5	Group B	Static message	1	Comprehension
Part 6	Group B	Flash message	2	Comprehension
Part 7	50 % of Group B	Static message seen last	1	Preference
Part 8	50% of Group B	Flash message seen last	2	Preference
Group A and Group B: 100% of Subjects				
Part 9	Group A and Group B	Flash message	1	Reading time
Part 10	Group A and Group B	Flash message	2	Reading time
Part 11	Group A and Group B	Static message	1	Reading time
Part 12	Group A and Group B	Static message	2	Reading time

**MAJOR ACCIDENT
AT LITTLE YORK
3 LANES CLOSED**

Message 1

**FREEWAY BLOCKED
AT TIDWELL
USE OTHER ROUTES**

Message 2

Experimental Protocol for Subjects in Group A

Instructions by Study Administrator

We are going to be taking a trip between downtown Houston and downtown Dallas. As you travel this route, you will see several guide signs and changeable message signs. After you pass each sign, I will ask you a few questions about the information on the sign. So try to remember the information in the message. While I ask the questions, continue to drive.

PART 1

Message displayed: *flashing message for Group A*: ***SIGN 1 (1-1F)***

**MAJOR ACCIDENT
AT LITTLE YORK
3 LANES CLOSED**

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What was told about the lanes?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 2

Message displayed: *non-flashing message for Group A*: ***SIGN 2 (1-2N)***

FREEWAY BLOCKED **AT TIDWELL** **USE OTHER ROUTES**

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What are you to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 3

This part of the study is for subjects who view the flashing message after they view the message that does not flash. After viewing the flashing message, subjects will be given the instructions that follow.

Instructions by Study Administrator (Group A, Part 3)

In the next part of the study, you will see two ways of displaying the same message. After you view both message styles, you will be asked to let us know which style you like the best.

The first message style is identical to the message you just saw. The message will flash on and off a few seconds. Then the message will turn off.

Message displayed: *flashing message for Group A*: ***SIGN 3 (1-1F)***

MAJOR ACCIDENT
AT LITTLE YORK
3 LANES CLOSED

The second message style will have the same message as the first, but it will not flash on and off. The message will stay on for a few seconds. Then it will turn off.

Message displayed: *non-flashing message for Group A*: ***SIGN 4 (1-1N)***

MAJOR ACCIDENT
AT LITTLE YORK
3 LANES CLOSED

Questions by Study Administrator

1. Which message style do you prefer?
   ____ ***The first message style (shown previously)***
   ____ ***The second message style (shown last)***

2. Why do you prefer the message style that you selected?
   Answer_____
   _____
   _____

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 4

This part of the study is for subjects who view the non-flashing message after they view the flashing message. After viewing the flashing message, subjects will be given the instructions that follow.

Instructions by Study Administrator (Group A, Part 4)

In the next part of the study, you will see two ways of displaying the same message. After you view both message styles, you will be asked to let us know which style you like best.

The first message is identical to the message you just saw. The message will remain on the screen for a few seconds. Then it will turn off.

Message displayed: *non-flashing message for Group A*: ***SIGN 5 (1-2N)***

FREEWAY BLOCKED **AT TIDWELL** **USE OTHER ROUTES**

The second message style has the same message as the first, but it will flash on and off for a few seconds. Then the message will turn off.

Message displayed: *flashing message for Group A*: ***SIGN 6 (1-2F)***

FREEWAY BLOCKED **AT TIDWELL** **USE OTHER ROUTES**

Questions by Study Administrator

1. Which message style do you prefer?
   ____ ***The first message style (shown previously)***
   ____ ***The second message style (shown last)***

2. Why do you prefer the message style that you selected?
   Answer_____
   _____
   _____

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

Experimental Protocol for Subjects in Group B

Instructions by Study Administrator

We are going to be taking a trip between downtown Houston and downtown Dallas. As you travel this route, you will see several guide signs and changeable message signs. After you pass each sign, I will ask you a few questions about the information on the sign. So try to remember the information in the message. While I ask the questions, continue to drive.

PART 5

Message displayed: *non-flashing message for Group B*: ***SIGN 7 (1-1N)***

MAJOR ACCIDENT **AT LITTLE YORK** **3 LANES CLOSED**

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What is told about the lanes?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 6

Message displayed: *flashing message for Group B*: ***SIGN 8 (1-2F)***

FREEWAY BLOCKED **AT TIDWELL** **USE OTHER ROUTES**

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What are you to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 7

This part of the study is for subjects who view the non-flashing message after they view the flashing message. After viewing the non-flashing message, subjects will be given the instructions that follow.

Instructions Shown on Screen to Subject (Group B, Part 7)

In the next part of the study, you will see two ways of displaying the same message. After you view both message styles, you will be asked to let us know which style you like best.

The first message is identical to the message you just saw. The message will stay on for a few seconds. Then it will turn off.

Message displayed: *non-flashing message for Group B*: ***SIGN 9 (1-1N)***

MAJOR ACCIDENT **AT LITTLE YORK** **3 LANES CLOSED**

The second message style will have the same message as the first, but it will flash on and off. The message will stay on for a few seconds. Then it will turn off.

Message displayed: *flashing message for Group B*: ***SIGN 10 (1-1F)***

MAJOR ACCIDENT **AT LITTLE YORK** **3 LANES CLOSED**

Questions by Study Administrator:

1. Which message style do you prefer?
   ____ ***The first message style (shown previously)***
   ____***The second message style (shown last)***

2. Why do you prefer the message style that you selected?
   Answer_____
   _____
   _____

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 8

This part of the study is for subjects who view the flashing message after they view the non-flashing message. After viewing the flashing message, subjects will be given the instructions that follow.

Instructions By Study Administrator (Group B, Part 8)

In the next part of the study, you will see two ways of displaying the same message. After you view both message styles, you will be asked to let us know which style you like best.

The first message is identical to the message you just saw. The message will flash on and off for a few seconds. Then the message will turn off.

Message displayed: *flashing message for Group B*: ***SIGN 11 (1-2F)***

FREEWAY BLOCKED
AT TIDWELL
USE OTHER ROUTES

The second message style will have the same message as the first, but it will not flash on and off. The message will stay on for a few seconds. Then it will turn off.

Message displayed: *non-flashing message for Group B*: ***SIGN 12 (1-2N)***

FREEWAY BLOCKED
AT TIDWELL
USE OTHER ROUTES

Questions by Study Administrator:

1. Which message style do you prefer?
   ____ *The first message style* ***(shown previously)***
   ____ *The second message style* ***(shown last)***

2. Why do you prefer the message style that you selected?
   Answer_____
   _____
   _____

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

Experimental Protocol for Subjects in Groups A and B

PART 9

This part of the study is designed to determine reading times. Subjects will view one of two flashing messages. Half the subjects will view Message 1 (Part 9) and the other half will view Message 2 (Part 10).

Instructions by Study Administrator (Group A & B, Part 9)

The next sign you see will be a changeable message sign. The instant you have read the message, press the button on the steering wheel to turn the message off. Then you will be asked questions about the information in the message. So try to remember the information in the message.

Message 1 displayed: *flashing message for Group A & B*: ***SIGN 13 (1-1F)***

MAJOR ACCIDENT
AT LITTLE YORK
3 LANES CLOSED

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What is told about the lanes?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 10

This part of the study is designed to determine reading times. Subjects will view one of two flashing messages. Half the subjects will view Message 1 (Part 9) and the other half will view Message 2 (Part 10).

Instructions by Study Administrator (Group A & B, Part 10)

The next sign you see will be a changeable message sign. The instant you have read the message, press the button on the steering wheel to turn the message off. Then you will be asked questions about the information in the message. So try to remember the information in the message.

Message 2 displayed: *flashing message for Group A & B*: ***SIGN 14 (1-2F)***

FREEWAY BLOCKED
AT TIDWELL
USE OTHER ROUTES

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What are you to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 11

This part of the study is designed to determine reading times. Subjects will view one of two non-flashing messages. Half the subjects will view Message 1 (Part 11) and the other half will view Message 2 (Part 12).

Instructions by Study Administrator (Group A & B, Part 11)

The next sign you see will be a changeable message sign. The instant you have read the message, press the button on the steering wheel to turn the message off. Then you will be asked questions about the information in the message. So try to remember the information in the message.

Message 1 displayed: *non-flashing message for Group A & B*: ***SIGN 15 (1-1N)***

MAJOR ACCIDENT **AT LITTLE YORK** **3 LANES CLOSED**

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What is told about the lanes?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 12

This part of the study is designed to determine reading times. Subjects will view one of two non-flashing messages. Half the subjects will view Message 1 (Part 11) and the other half will view Message 2 (Part 12).

Instructions by Study Administrator (Group A & B, Part 12)

The next sign you see will be a changeable message sign. The instant you have read the message, press the button on the steering wheel to turn the message off. Then you will be asked questions about the information in the message. So try to remember the information in the message.

Message 2 displayed: *non-flashing message for Group A & B*: ***SIGN 16 (1-2N)***

FREEWAY BLOCKED
AT TIDWELL
USE OTHER ROUTES

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What are you to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

Data Analysis

1. Number and percent of subjects that correctly identify the traffic problem.
2. Number and percent of subjects that correctly identify where the traffic problem is located.
3. Number and percent of subjects that correctly identify what they are to do.
4. Number and percent preference for each message style.
5. Appropriate statistical comparisons of reading times for each message style.

STUDY 2: EVALUATE FLASHING ONE LINE OF A ONE-PHASE MESSAGE VS A NON-FLASHING ONE-PHASE MESSAGE

Objectives

The objectives of this study are to:

1. Determine motorist comprehension of a one-phase message when the top line (problem statement) flashes versus a message with no flashing lines;
2. Determine motorist preferences for each of the two message styles; and
3. Determine motorist reading times for each of the two message styles.

Background

There is a perception by some TMC managers that flashing the top line (problem statement) of a one-phase message will attract the attention of the motorists to the sign. However, it is not clear what effect flashing a single line has on driver comprehension and reading times of the entire message. For example, does the flashing line cause drivers to concentrate more on that line than the remainder of the message?

Method

The study method will be identical to Study 1 with the exception that only the top line will flash. The characteristics of the study are shown in Table 2.

Experimental Protocol for Subjects in Group A

Instructions by Study Administrator

We are going to be taking a trip between downtown Houston and downtown Dallas. As you travel this route, you will see several guide signs and changeable message signs. After you pass each sign, I will ask you a few questions about the information on the sign. So try to remember the information in the message. While I ask the questions, continue to drive.

PART 1

Message displayed: *message with flashing top line for Group A*: ***SIGN 17 (2-1F)***

FREEWAY CLOSED
AT COLLEGE ST
FOLLOW DETOUR

Table 2. Characteristics of Study Design for Flashing One Line

Study Part	Group	Message Type	Message Text	Output
Group A: 50% of Subjects				
Part 1	Group A	Flash message line	1	Comprehension
Part 2	Group A	Static message	2	Comprehension
Part 3	50 % of Group A	Flash line message seen last	1	Preference
Part 4	50% of Group A	Static message seen last	2	Preference
Group B: 50% of Subjects				
Part 5	Group B	Static message	1	Comprehension
Part 6	Group B	Flash message line	2	Comprehension
Part 7	50 % of Group B	Static message seen last	1	Preference
Part 8	50% of Group B	Flash message seen last	2	Preference
Group A and Group B: 100% of Subjects				
Part 9	Group A and Group B	Flash message line	1	Reading time
Part 10	Group A and Group B	Flash message line	2	Reading time
Part 11	Group A and Group B	Static message line	1	Reading time
Part 12	Group A and Group B	Static message line	2	Reading time

FREEWAY CLOSED
AT COLLEGE ST
FOLLOW DETOUR

Message 1

TRUCK ACCIDENT
AT AIRPORT RD
USE SERVICE ROAD

Message 2

Questions by Study Administrator:

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What are you to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 2

Message displayed: *non-flashing line message for Group A*: ***SIGN 18 (2-2N)***

TRUCK ACCIDENT **AT AIRPORT RD** **USE SERVICE ROAD**

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What are you to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 3

This part of the study is for subjects who view the message with the flashing line after they view the message that does not flash. After viewing the flashing message, subjects will view the following.

Instructions by Study Administrator (Group A, Part 3)

In the next part of the study, you will see two ways of displaying the same message. After you view both message styles, you will be asked to let us know which style you like best.

The first message is identical to the message you just saw. The message will remain on the screen for a few seconds. Then it will turn off.

Message displayed: *message with flashing top line for Group A*: ***SIGN 19 (2-1F)***

FREEWAY CLOSED **AT COLLEGE ST** **FOLLOW DETOUR**

The second message style will have the same message as the first but the top line will not be flashing. The message will stay on the screen for a few seconds. Then it will turn off.

Message displayed: *non-flashing line message for Group A*: ***SIGN 20 (2-1N)***

FREEWAY CLOSED **AT COLLEGE ST** **FOLLOW DETOUR**

Questions by Study Administrator

1. Which message style do you prefer?
   ____ ***The first message style (shown previously)***
   ____ ***The second message style (shown last)***

2. Why do you prefer the message style that you selected?
   Answer _____
   _____
   _____

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 4

This part of the study is for subjects who view the message without the flashing line after they view the message with the flashing line. After viewing the message without the flashing line, subjects will view the following.

Instructions Shown on Screen to Subject (Group A, Part 4)

In the next part of the study, you will see two ways to displaying the same message. After you view both message styles, you will be asked to let us know which style you like best.

The first message is identical to the message you just saw. The message will remain on the screen for a few seconds. Then the message will turn off.

Message displayed: *non-flashing top line message for Group A*: ***SIGN 21 (2-2N)***

TRUCK ACCIDENT
AT AIRPORT ROAD
USE SERVICE ROAD

The second message style will have the same message as the first but the top line will be flashing. The message will stay on the screen for a few seconds. Then it will turn off.

Message displayed: *message with flashing top line for Group A*: ***SIGN 22 (2-2F)***

TRUCK ACCIDENT
AT AIRPORT ROAD
USE SERVICE ROAD

Questions by Study Administrator

1. Which message style do you prefer?
   ____ ***The first message style (shown previously)***
   ____ ***The second message style (shown last)***

2. Why do you prefer the message style that you selected?
   Answer _____
   _____
   _____

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

Experimental Protocol for Subjects in Group B

Instructions by Study Administrator

We are going to be taking a trip between downtown Houston and downtown Dallas. As you travel this route, you will see several guide signs and changeable message signs. After you pass each sign, I will ask you a few questions about the information on the sign. So try to remember the information in the message. While I ask the questions, continue to drive.

PART 5

Message displayed: *non-flashing message for Group B*: ***SIGN 23 (2-1N)***

FREEWAY CLOSED
AT COLLEGE ST
FOLLOW DETOUR

Questions by Study Administrator:

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What are you to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 6

Instructions Shown on Screen to Subject (Group B, Part 6)

Message displayed: *message with flashing top line for Group B*: ***SIGN 24 (2-2F)***

TRUCK ACCIDENT
AT AIRPORT RD
USE SERVICE ROAD

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What are you to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 7

This part of the study is for subjects who view the message without the flashing line after they view the message with the flashing top line. After viewing the flashing message, subjects will be given the instructions that follow

Instructions by Study Administrator (Group B, Part 7)

In the next part of the study, you will see two ways of displaying the same message. After you view both message styles, you will be asked to let us know which style you like best.

The first message is identical to the message you just saw. The message will remain on the screen for a few seconds. Then it will turn off.

Message displayed: *non-flashing message for Group B*: ***SIGN 25 (2-1N)***

FREEWAY CLOSED
AT COLLEGE ST
FELLOW DETOUR

The second message style will have the same message as the first but the top line will flash on and off. The message will stay on the screen for a few seconds. Then it will turn off.

Message displayed: *non-flashing line message for Group A*: ***SIGN 26 (2-1F)***

FREEWAY CLOSED **AT COLLEGE ST** **FELLOW DETOUR**

Questions by Study Administrator

1. Which message style do you prefer?
   ____ ***The first message style (shown previously)***
   ____ ***The second message style (shown last)***

2. Why do you prefer the message style that you selected?
   Answer _____
   _____
   _____

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 8

This part of the study is for subjects who view the message with the flashing line after they view the message that does not flash. After viewing the flashing message, subjects will view the following.

Instructions by Study Administrator (Group B, Part 8)

In the next part of the study, you will see two ways of displaying the same message. After you view both message styles, you will be asked to let us know which style you like best.

The first message is identical to the message you just saw. The top line of the message will flash on and off. The message will remain on the screen for a few seconds. Then the message will turn off.

Message displayed: *message with flashing top line for Group B*: ***SIGN 27 (2-2F)***

TRUCK ACCIDENT **AT AIRPORT RD** **USE SERVICE ROAD**

The second message style will have the same message as the first but the top line will not be flashing. The message will stay on the screen for a few seconds. Then it will turn off.

Message displayed: *non-flashing line message for Group B*: ***SIGN 28 (2-2N)***

TRUCK ACCIDENT
AT AIRPORT RD
USE SERVICE ROAD

Questions by Study Administrator

1. Which message style do you prefer?
   ____ ***The first message style (shown previously)***
   ____ ***The second message style (shown last)***

2. Why do you prefer the message style that you selected?
   Answer_____
   _____
   _____

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

Experimental Protocol for Subjects in Groups A and B

PART 9

This part of the study is designed to determine reading times. Subjects will view one of two messages with the top line flashing. Half the subjects will view Message 1 (Part 9) and the other half will view Message 2 (Part 10).

Instructions by Study Administrator (Group A & B, Part 9)

The next sign you see will be a changeable message sign. The instant you have read the message, press the button on the steering wheel to turn the message off. Then you will be asked questions about the information in the message. So try to remember the information in the message.

Message 1 displayed: *message with flashing top line for Group A & B*: ***SIGN 29 (2-1F)***

FREEWAY CLOSED
AT COLLEGE ST
FOLLOW DETOUR

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What are you to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 10

This part of the study is designed to determine reading times. Subjects will view one of two messages with the top line flashing. Half the subjects will view Message 1 (Part 9) and the other half will view Message 2 (Part 10).

Instructions Shown on Screen to Subject (Group A & B, Part 10)

The next sign you see will be a changeable message sign. The instant you have read the message, press the button on the steering wheel to turn the message off. Then you will be asked questions about the information in the message. So try to remember the information in the message.

Message 2 displayed: *message with flashing top line for Group A & B*: ***SIGN 30 (2-2F)***

TRUCK ACCIDENT **AT AIRPORT RD** **USE SERVICE ROAD**

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What are you to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 11

This part of the study is designed to determine reading times. Subjects will view one of two non-flashing line messages. Half the subjects will view Message 1 (Part 11) and the other half will view Message 2 (Part 12).

Instructions by Study Administrator (Group A & B, Part 11)

The next sign you see will be a changeable message sign. The instant you have read the message, press the button on the steering wheel to turn the message off. Then you will be asked questions about the information in the message. So try to remember the information in the message.

Message 1 displayed: *non-flashing line message for Group A & B*: ***SIGN 31 (2-1N)***

FREEWAY CLOSED **AT COLLEGE ST** **FOLLOW DETOUR**

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What are you to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 12

This part of the study is designed to determine reading times. Subjects will view one of two non-flashing line messages. Half the subjects will view Message 1 (Part 11) and the other half will view Message 2 (Part 12).

Instructions by Study Administrator (Group A & B, Part 11)

The next sign you see will be a changeable message sign. The instant you have read the message, press the button on the steering wheel to turn the message off. Then you will be asked questions about the information in the message. So try to remember the information in the message.

Message 2 displayed: *non-flashing line message for Group A & B*: ***SIGN 32 (2-2N)***

TRUCK ACCIDENT **AT AIRPORT RD** **USE SERVICE ROAD**

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. What are you to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

Data Analysis

1. Number and percent of subjects that correctly identify the traffic problem.
2. Number and percent of subjects that correctly identify where the traffic problem is located.
3. Number and percent of subjects that correctly identify what they are to do.
4. Number and percent preference for each message style.
5. Appropriate statistical comparisons of reading times for each message style.

STUDY 3: EVALUATE THE EFFECT OF ALTERNATING TEXT ON ONE LINE OF A THREE-LINE CMS WHILE KEEPING THE OTHER TWO LINES OF TEXT CONSTANT ON THE SECOND PHASE

Objectives

The objectives of this study are to:

1. Determine motorist comprehension of redundancy in the form of repetition in a two-phase message when the bottom line changes while the other two lines remain the same versus a two-phase message without redundancy;
2. Determine motorist preferences for each of the two message styles; and
3. Determine motorist reading times for each of the two message styles.

Background

Some transportation agencies incorporate redundancy in the form of repetition of lines of text in two-phase messages. Generally, the two top lines remain the same while the bottom line changes text. It is not clear what effect the redundancy has on motorist comprehension and reading times of the entire message. For example, do the repetitive lines cause motorists to read these lines more than once thus increasing reading times? Also, there is uncertainty whether motorists actually notice that the bottom line changes.

Method

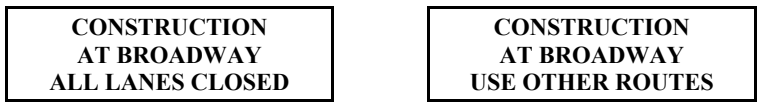
The study method will be identical to Study 1 with the exception that message styles will be different. For this study, two alternative two-phase messages will be compared. The top two lines for one message will remain the same (repetitive) while the bottom line will change. The second message will contain the same information with the redundancy removed. The characteristics of the study are shown in Table 3.

Experimental Protocol for Subjects in Group A

We are going to be taking a trip between downtown Houston and downtown Dallas. As you travel this route, you will see several guide signs and changeable message signs. After you pass each sign, I will ask you a few questions about the information on the sign. So try to remember the information in the message. While I ask the questions, continue to drive.

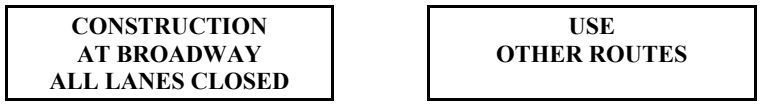
Table 3. Characteristics of Study Design for Redundancy in a Two-Phase Message

Study Part	Group	Message Type	Message Text	Output
Group A: 50% of Subjects				
Part 1	Group A	Redundancy with alternating line	1	Comprehension
Part 2	Group A	No redundancy	2	Comprehension
Part 3	50 % of Group A	Redundancy with alternating line message seen last	1	Preference
Part 4	50% of Group A	No redundancy message seen last	2	Preference
Group B: 50% of Subjects				
Part 5	Group B	No redundancy	1	Comprehension
Part 6	Group B	Redundancy with alternating line	2	Comprehension
Part 7	50 % of Group B	No redundancy message seen last	1	Preference
Part 8	50% of Group B	Redundancy with alternating line message seen last	2	Preference
Group A and Group B: 100% of Subjects				
Part 9	Group A and Group B	Redundancy with alternating line	1	Reading time
Part 10	Group A and Group B	Redundancy with alternating line	2	Reading time
Part 11	Group A and Group B	No redundancy	1	Reading time
Part 12	Group A and Group B	No redundancy	2	Reading time



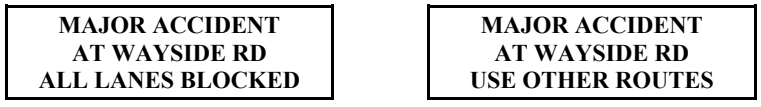
Phase 1 *Phase 2*

Message 1 With Redundancy



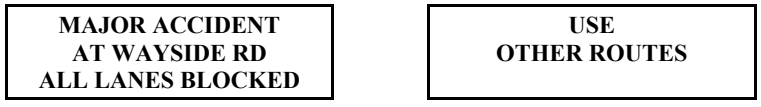
Phase 1 *Phase 2*

Message 1 No Redundancy



Phase 1 *Phase 2*

Message 2 With Redundancy



Phase 1 *Phase 2*

Message 2 No Redundancy

PART 1

Message displayed: *alternating third line message for Group A*: ***SIGN 33 (3-1F)***

CONSTRUCTION **AT BROADWAY RD** **ALL LANES CLOSED**	**CONSTRUCTION** **AT BROADWAY RD** **USE OTHER ROUTES**
1st Phase	*2nd Phase*

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. How many lanes are blocked?
4. What are you told to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 2

Message on screen: *shorter message for Group A*: ***SIGN 34 (3-2N)***

MAJOR ACCIDENT **AT WAYSIDE RD** **ALL LANES BLOCKED**	**USE** **OTHER ROUTES**
1st Phase	*2nd Phase*

Questions by Study Administrator:

1. What is the traffic problem?
2. Where is the traffic problem located?
3. How many lanes are blocked?
4. What are you told to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 3

This study is for subjects who view the alternating third line message after they view the shorter version of the same message. After viewing the alternating third line message, subjects will be given the instructions that follow.

Instructions by Study Administrator (Group A, Part 3)

In the next part of the study, you will see two ways of displaying the same message. After you view both styles, you will be asked to let us know which style you like best.

The first message style is identical to the message you just saw. The message will be in TWO parts. Then it will turn off.

Message displayed: *alternating third line message for Group A*: ***SIGN 35 (3-1F)***

CONSTRUCTION **AT BROADWAY RD** **ALL LANES CLOSED**	**CONSTRUCTION** **AT BROADWAY RD** **USE OTHER ROUTES**
1st Phase	*2nd Phase*

The second message style has the same message as the first, and will be shown in TWO parts. Then it will turn off.

Message displayed: *shorter message for Group A*: ***SIGN 36 (3-1N)***

CONSTRUCTION **AT BROADWAY RD** **ALL LANES CLOSED**	**USE** **OTHER ROUTES**
1st Phase	*2nd Phase*

Questions by Study Administrator

1. Which message style do you prefer?
   ____ ***The first message style (shown previously)***
   ____ ***The second message style (shown last)***

2. Why do you prefer the message style that you selected?
   Answer_____
   _____
   _____

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 4

This study is for subjects who view the shorter message after they view the alternating third line message. After viewing the shorter message, subjects will be given the instructions that follow.

Instructions by Study Administrator (Group A, Part 4)

In the next part of the study, you will see two ways of displaying the same message. After you view both styles, you will be asked to let us know which style you like best.

The first message style is identical to the message you just saw. The message will be in TWO parts. Then it will turn off.

Message displayed: *shorter message for Group A*: ***SIGN 37 (3-2N)***

MAJOR ACCIDENT AT WAYSIDE RD ALL LANES BLOCKED	**USE OTHER ROUTES**
1st Phase	*2nd Phase*

The second message style has the same message as the first, and will be shown in TWO parts. Then it will turn off.

Message displayed: *alternating third line message for Group A*: ***SIGN 38. (3-2F***

MAJOR ACCIDENT AT WAYSIDE RD ALL LANES BLOCKED	**MAJOR ACCIDENT AT WAYSIDE RD USE OTHER ROUTES**
1st Phase	*2nd Phase*

Questions by Study Administrator

1. Which message style do you prefer?
   ____ ***The first message style (shown previously)***
   ____ ***The second message style (shown last)***

2. Why do you prefer the message style that you selected?
   Answer_____
   _____
   _____

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

Experimental Protocol for Subjects in Group B

PART 5

We are going to be taking a trip between downtown Houston and downtown Dallas. As you travel this route, you will see several guide signs and changeable message signs. After you pass

each sign, I will ask you a few questions about the information on the sign. So try to remember the information in the message. While I ask the questions, continue to drive.

Message displayed: *shorter message for Group B*: ***SIGN 39 (3-1N)***

CONSTRUCTION **AT BROADWAY RD** **ALL LANES CLOSED**	**USE** **OTHER ROUTES**
1st Phase	*2nd Phase*

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. How many lanes are blocked?
4. What are you told to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 6

Message displayed: *alternating third line message for Group B*: ***SIGN 40 (3-2F)***

MAJOR ACCIDENT **AT WAYSIDE RD** **ALL LANES BLOCKED**	**MAJOR ACCIDENT** **AT WAYSIDE RD** **USE OTHER ROUTES**
1st Phase	*2nd Phase*

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. How many lanes are blocked?
4. What are you told to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 7

This study is for subjects who view the shorter message after they view the alternating third line message. After viewing the shorter message, subjects will be given the instructions that follow.

Instructions by Study Administrator (Group B, Part 7)

In the next part of the study, you will see two ways of displaying the same message. After you view both message styles, you will be asked to let us know which style you like best.

The first message style is identical to the message you just saw. The message will be in TWO parts. Then it will turn off.

Message displayed: *shorter message for Group B*: ***SIGN 41 (3-1N)***

CONSTRUCTION AT BROADWAY RD ALL LANES CLOSED	USE OTHER ROUTES
1st Phase	*2nd Phase*

The second message style has the same message as the first, and will be shown in TWO parts. Then it will turn off.

Message displayed: *alternating third line message for Group B*: ***SIGN 42 (3-1F)***

CONSTRUCTION AT BROADWAY RD ALL LANES CLOSED	CONSTRUCTION AT BROADWAY RD USE OTHER ROUTES
1st Phase	*2nd Phase*

Questions by Study Administrator

1. Which message style do you prefer?
   ____ ***The first message style (shown previously)***
   ____ ***The second message style (shown last)***

2. Why do you prefer the message style that you selected?
   Answer_____
   _____
   _____

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 8

This study is for subjects who view the alternating third line message (Message 1) after they view the shorter message (Message 2). After viewing the shorter message, subjects will be given the instructions that follow.

Instructions by Study Administrator (Group B, Part 8)

In the next part of the study, you will see two ways of displaying the same message. After you view both message styles, you will be asked to let us know which style you like best.

The first message is identical to the message you just saw. The message will stay on for a few seconds. Then it will turn off.

Message displayed: *alternating third line message for Group B*: ***SIGN 43 (3-2F)***

MAJOR ACCIDENT **AT WAYSIDE RD** **ALL LANES BLOCKED**	**MAJOR ACCIDENT** **AT WAYSIDE RD** **USE OTHER ROUTES**
1st Phase	*2nd Phase*

The second message style has the same message as the first, and will be shown in TWO parts. Then it will turn off.

Message displayed: *shorter message for Group B*: ***SIGN 44 (3-2N)***

MAJOR ACCIDENT **AT WAYSIDE RD** **ALL LANES BLOCKED**	**USE** **OTHER ROUTES**
1st Phase	*2nd Phase*

Questions by Study Administrator

1. Which message style do you prefer?
   ____ ***The first message style (shown previously)***
   ____ ***The second message style (shown last)***

2. Why do you prefer the message style that you selected?
   Answer_____
   _____
   _____

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

Experimental Protocol for Subjects in Groups A and B

PART 9

This part of the study is designed to determine reading times. Subjects will view one of two messages. Half the subjects will view Message 1 (Part 9) and the other half will view Message 2 (Part 10).

Instructions Shown on Screen to Subject (Group A & B, Part 9)

The next sign you see will be a changeable message sign. The message will be shown in two parts. After the second part of the message is shown the message will repeat. The instant you have read the entire message, press the button on the steering wheel to turn the message off. Then you will be asked questions about the information in the message. So try to remember the information in the message.

Message 1 displayed: *alternating third line message for Group A & B*: ***SIGN 45 (3-1F)***

CONSTRUCTION **AT BROADWAY RD** **ALL LANES CLOSED**	**CONSTRUCTION** **AT BROADWAY RD** **USE OTHER ROUTES**
1st Phase	*2nd Phase*

Questions by Study Administrator

1. What is the traffic problem?
5. Where is the traffic problem located?
3. How many lanes are blocked?
4. What are you told to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 10

This part of the study is designed to determine reading times. Subjects will view one of two messages. Half the subjects will view Message 1 (Part 9) and the other half will view Message 2 (Part 10).

Instructions Shown on Screen to Subject (Group A & B, Part 10)

The next sign you see will be a changeable message sign. The message will be shown in two parts and then will repeat. The instant you have read the entire message, press the button on the steering wheel to turn the message off. Then you will be asked questions about the information in the message. So try to remember the information in the message.

Message 2 displayed: *alternating third line message for Group A & B*: ***SIGN 46 (3-2F)***

MAJOR ACCIDENT AT WAYSIDE RD ALL LANES BLOCKED	**MAJOR ACCIDENT AT WAYSIDE RD USE OTHER ROUTES**
1st Phase	*2nd Phase*

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. How many lanes are blocked?
4. What are you told to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 11

This part of the study is designed to determine reading times. Subjects will view one of two messages. Half the subjects will view Message 1 (Part 11) and the other half will view Message 2 (Part 12).

Instructions Shown on Screen to Subject (Group A & B, Part 11)

The next sign you see will be a changeable message sign. The message will be shown in two parts and then will repeat. The instant you have read the entire message, press the button on the steering wheel to turn the message off. Then you will be asked questions about the information in the message. So try to remember the information in the message.

Message 1 displayed: *shorter message for Group A & B*: ***SIGN 47 (3-1N)***

CONSTRUCTION AT BROADWAY RD ALL LANES CLOSED	**USE OTHER ROUTES**
1st Phase	*2nd Phase*

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. How many lanes are blocked?
4. What are you told to do?

(The next sign that the subject sees will be determined when the experimental parts are packaged for each subject group.)

PART 12

This part of the study is designed to determine reading times. Subjects will view one of two messages. Half the subjects will view Message 1 (Part 11) and the other half will view Message 2 (Part 12).

Instructions Shown on Screen to Subject (Group A & B, Part 12)

The next sign you see will be a changeable message sign. The message will be shown in two parts and then will repeat. The instant you have read the entire message, press the button on the steering wheel to turn the message off. Then you will be asked questions about the information in the message. So try to remember the information in the message.

Press the space bar to view the TWO- part message –

Message 2 displayed: *shorter message for Group A & B*: ***SIGN 48 (3-2N)***

MAJOR ACCIDENT **AT WAYSIDE RD** **ALL LANES BLOCKED**	**USE** **OTHER ROUTES**
1st Phase	*2nd Phase*

Questions by Study Administrator

1. What is the traffic problem?
2. Where is the traffic problem located?
3. How many lanes are blocked?
4. What are you told to do?

(The next sign that the subject sees will be directed to will be determined when the experimental parts are packaged for each subject group.)

Data Analysis

1. Number and percent of subjects that correctly identify the traffic problem.
2. Number and percent of subjects that correctly identify where the traffic problem is located.
3. Number and percent of subjects that correctly identify the number of lanes affected.
4. Number and percent of subjects that correctly identify what the sign tells them to do.
5. Number and percent preference for each message style.
6. Appropriate statistical comparisons of reading times for each message style.

APPENDIX A
MESSAGES FOR HUMAN FACTORS STUDIES: DRIVER SIMULATOR

Message 1-1F	Message 1-1N	Message 1-2F	Message 1-2N
MAJOR ACCIDENT **AT LITTLE YORK** **3 LANES CLOSED**	MAJOR ACCIDENT AT LITTLE YORK 3 LANES CLOSED	**FREEWAY BLOCKED** **AT TIDWELL** **USE OTHER ROUTES**	FREEWAY BLOCKED AT TIDWELL USE OTHER ROUTES

Message 2-1F	Message 2-1N	Message 2-2F	Message 2-2N
FREEWAY CLOSED AT COLLEGE ST FOLLOW DETOUR	FREEWAY CLOSED AT COLLEGE ST FOLLOW DETOUR	**TRUCK ACCIDENT** AT AIRPORT RD USE SERVICE ROAD	TRUCK ACCIDENT AT AIRPORT RD USE SERVICE ROAD

Message 3-1F	Message 3-1N	Message 3-2F	Message 3-2N
CONSTRUCTION AT BROADWAY RD **ALL LANES CLOSED** CONSTRUCTION AT BROADWAY RD **USE OTHER ROUTES**	CONSTRUCTION AT BROADWAY RD ALL LANES CLOSED USE OTHER ROUTES	MAJOR ACCIDENT AT WAYSIDE RD **ALL LANES BLOCKED** MAJOR ACCIDENT AT WAYSIDE RD **USE OTHER ROUTES**	MAJOR ACCIDENT AT WAYSIDE RD ALL LANES BLOCKED USE OTHER ROUTES

Note: F = Flashing or alternating line; N = Non flashing or alternating line. Bold indicates the portion of the message that flashes or alternates